Chapter Four

Impacts of Exploration, Development, and Production

At the annual meeting of the Rocky Mountain Oil and Gas Association in October 1992, former Energy Secretary Watkins cautioned his audience that then-Governor Clinton and his running mate, Senator Albert Gore, claim to endorse natural gas as a fuel, "but they haven't got to the chapter on drilling yet. They don't know it comes from there."[64]

The Myth of Safe Extraction

Admiral Watkins was admonishing the oil and gas industry to resist complacency about public and political acceptance of gas as a harmless fuel when the public becomes more informed. And well he might. Even a cursory look at the impacts of exploration, development, and production of natural gas quickly dispels the myth that natural gas is a clean fuel.

The polluting and disrupting impacts of exploration and production are amplified by the fact that many of the gas fields under production today, and even more awaiting production, lie in ecologically vulnerable regions such as the Arctic and offshore.

Nearly one-third of U.S. natural gas production is offshore,[65] and offshore regions continue to be targeted for new exploration and production. The Minerals Management Service (the branch of the U.S. Department of Interior that administers the offshore drilling program in federal waters from 3 to 200 miles offshore) changed the name of its new five-year plan for offshore drilling from the *Outer Continental Shelf (OCS) Oil and Gas 5-Year Leasing Program* to the *OCS Natural Gas and Oil Resource Management Program*. The reversal was made, in their words, to "support the nation's overwhelming interest in increasing the use of natural gas."[66] According to the Minerals Management Service (MMS):

> Natural gas is the predominant energy resource produced on the OCS. It is clean, easy to use and transport, and it readily burns with different types of equipment. It poses little or no environmental threat."[67]

In fact, exploration, development, and production of natural gas pose the same risks as oil extraction activities. Oil and gas often occur together in geological formations and are extracted and processed by the same industry. It is highly unlikely that petroleum producers will simply separate the oil from the gas and leave it behind or re-inject it into the reservoir. Because gas production requires much greater up-front investment, the opportunity to market oil as well as gas is often the deciding factor in going forward with marginally profitable fields.

The change in semantics of the offshore leasing program seems a simplistic attempt to allow access to oil and gas fields simultaneously without the negative stigma of "oil drilling." Oil spills will certainly continue as a result of the MMS leasing program. But even should one discount the continued risk of large oil spills, other significant risks of natural gas exploration and production are equal to or greater than oil extraction alone. MMS publications claim that "natural gas blowouts are unlikely,"[68] when in reality MMS statistics reveal that out of 146 blowouts in the Gulf of Mexico between 1956 and 1986, 103 of them (more than two-thirds) were caused by gas blowouts. Of those gas blowouts, 39 caused major accidents (defined as causing damage of $1 million or more, hydrocarbon spills of 200 barrels or more, or fatalities or serious injuries causing impairment of "bodily unit or function").[69]

Exploration, development, and production of natural gas create the same environmental problems as oil exploration, and are briefly outlined below.

Drilling Muds

Every time an offshore well is drilled, 1,500 to 2,000 tons of toxic drilling muds and rock cuttings are generated (drilling muds are used to maintain downhole pressure, lubricate the drill bit, and pull cuttings away from the wellhead).[70] Comparable quantities are produced from onshore wells. These wastes contain volatile organic compounds, polycyclic aromatic hydrocarbons, arsenic, barium, lead, corrosive ions, and naturally occurring radioactive materials (NORM), including radium-226 and other hazardous substances.[71]

Drilling muds are sometimes disposed of by simply dumping them into the water column. If disposed of on land, they are exempt from the hazardous waste disposal requirements of the Resource Conservation and Recovery Act (RCRA), largely because the U.S. EPA ruled that disposal of the enormous volume of waste[72] would impose a financial burden on the industry that could curtail domestic production.[73]

Disposal of drilling wastes into the water column smothers benthic (bottom-dwelling) life, clogs the breathing and feeding mechanisms of organisms, toxifies sediments, and robs the water and the bottom sediments of oxygen. Senator Lloyd Bentsen commented that "the Gulf of Mexico is severely stressed environmentally...As much as 37 percent of Gulf shellfish beds are at risk of contamination."[74] One study reported discovery of a 3,000-square-mile "dead zone" along the Gulf bottom off Louisiana and Texas, where the water does not have enough oxygen to support marine life.[75]

Produced Water

Hydrocarbons are extracted from reservoirs in a complex stream that includes oil, natural gas, produced water (archaic water that was trapped along with the hydrocarbons in formation), and other gases and compounds. The produced water is separated out and disposed of in enormous quantities. The petroleum industry esti-

BOX 3: Orphan Wastes—Radioactive Contamination of Natural Gas

In 1990, a *New York Times* report informed the country of widespread radioactive contamination occurring in areas where produced water from oil and gas field production has been routinely dumped, and in discarded pipe and other apparatus used by the oil and gas industry.[1]

Virtually all oil and gas-producing regions also produce NORM (normally occurring radioactive materials), to varying degrees. The radioactivity is a consequence of radium leaching from the rocks that surround oil and gas reservoirs into the water that is brought to the surface when the oil and gas is extracted. And, although the industry has been aware of the presence of radium in produced water for many years, it was not viewed as a significant problem (even though producers in Louisiana and Alaska's North Slope had quietly stockpiled radium contaminated pipe for some years).

In one of those odd regulatory glitches that sometimes allows a poorly defined problem to escape oversight, NORM associated with oil and gas extractive activities have never been regulated, nor even monitored. If the documented level of radioactivity associated with oil and gas field wastes had occurred as a result of nuclear energy or weapons production, it would have fallen under the umbrella of the Nuclear Regulatory Commission. The *New York Times* article reported that wells tested in Louisiana and other southern states revealed "the oil-water mixture pumped to the surface contains radiation levels 5 to 30 times higher than the government allows to be released from nuclear power plants."

An industry consultant and editor of *The NORM Report*, Peter Gray, has dubbed NORM "orphan wastes" because of the lack of federal oversight.

The Louisiana Department of Environmental Quality (DEQ) found that the radium levels in "most" produced waters from the Gulf Coast Region exceeded proposed and existing radium discharge limits applied to other sectors.[2] The DEQ found that in the vicinity of fields where produced water dumping has occurred for decades, the total radium released to the environment at these sites could "be in excess of 10 curies."[3] They also found that the radioactive scale (which builds up on the interior of pipe and other equipment that contacts produced water from oil and gas wells) contained radium-226 concentrations hundreds of thousands of times greater than EPA-set hazardous levels.[4]

The Louisiana DEQ concluded: "The magnitude of the problem is difficult to estimate, but it is not unrealistic to expect contamination at all oil and gas production sites and pipe handling facilities."[5]

Since oil and gas-producing states first became aware of the extent of the NORM problem in 1988, several state regulatory agencies have formulated rules to regulate NORM-contaminated produced water and scale. But without oversight and regulation on a national scale, the state-level efforts are piecemeal and difficult to coordinate and still have not solved the problem of disposal. The U.S. EPA is planning a national conference on NORM and has released a report and preliminary risk assessment, but currently there are no U.S. EPA regulations for NORM control.[6] Nor does the U.S. Minerals Management Service monitor or regulate NORM contamination from oil and gas activities in the Outer Continental Shelf (with the exception of NORM-contaminated sands).

The radium contamination described above accompanies both oil and gas production. The quarterly *NORM Report* states that NORM contamination in the gas side of the petroleum industry is, in many ways, more severe than in the oil side of the in-

dustry. The *NORM Report's* editor commented that, "the highest radiation from NORM I have seen in the petroleum industry was from a propane pump in an NGL [natural gas liquids] plant."[7]

This additional problem occurs with natural gas throughout the entire production-processing-distribution system as a consequence of radon contamination and its long-lived decay products.[8] As with radium, radon is produced with natural gas at the wellhead. Although radon has a half-life of only 3.8 days, that is long enough to ensure that it is present in some natural gas products delivered for direct household use. However, according to Peter Gray, that is not where the problem lies, as the radon is simply combusted when the fuel is burned;[9] the more significant problem is found in natural gas processing plants where long-lived radon decay products accumulate in sludge, the disposal of which is unregulated by any federal agency.[10]

According to Gray:

> "...the concentrations of radioactive lead, bismuth, and polonium [decay products of radon] will continue to increase in pipelines, gasoline plants, tank cars, and trucks for over 100 years...Although entire natural gas and NGL systems may be contaminated with NORM, some facilities will be contaminated to the extent that they present significant decontamination and disposal problems."[11]

In recognition of the growing awareness of the problem of NORM contamination in the gas industry, the U.S. Department of Energy (DOE) identifies the problem as a major tactical element of their recently published *Natural Gas Strategic Plan*: "Naturally occurring radioactive materials (NORM) in gas will become an increasing issue."[12] DOE's natural gas strategic plan does not, however, define the problem, offer a solution, or even describe a process to begin addressing the problem.

Notes

1. Schneider, Keith."Radioactivity Taints Nation's Oil Fields." *New York Times* in *Anchorage Daily News* 12/11/90.

2. Louisiana Department of Environmental Qaulity. *"Draft: Technologically-enhanced Natural Radiation Interim Policy Pipe Scale."* Nuclear Energy Division, 10/10/1988; 76 percent of the samples tested showed radium levels of greater then 50 picocuries (pCi) per liter. The U.S. EPA has proposed regulations that establish 50 pCi/liter as the level of activity that distinguishes betweeen hazardous and nonhazardous waste.

3. Ibid.

4. Ibid; up to 100,000 pCi/gm, and up to 8,700 pCi/gm in soil contaminated by radioactive scale at pipe storage areas; as a point of comparison, natural background radium-226 activity in Louisiana soils ranges from less than one to about 7 pCi/gm. Note: The high radium activity associated with scale is referred to as "technologically enhanced natural radiation," or TENR.

5. Ibid.

6. Gray, Peter. "Regulations for the Control of NORM- Update." *The Norm Report* Tulsa, OK: Peter Gray and Associates,Winter 1992, p.31.

7. Ibid.

8. Gray, Peter. "Radium/Radon NORM." *The Norm Report Tulsa, OK: Peter Gray and Associates; Winter 1992, p.1.*

9. Personal communication with Peter Gray on 11/30/92.

10. Ibid.

11. Gray, Peter. "Radioactive Materials Could Pose Problems for the Gas Industry." *Oil And Gas Journal* 6/25/90.

12. U.S. Department of Energy. *Natural Gas Strategic Plan And Multiyear Program Crosscut Plan, FY 1992-1998,* DOE/FE-0251P, April 1992.

mates that 1.5 million barrels of produced water are discharged into the Gulf of Mexico daily (much of it from gas production).[76]

Produced water, or "toxic brine" as it is more accurately described in the industry, contains NORM, cadmium, lead, benzene, napthalene, zinc, emulsified oil, and grease.[77] Toxic brine that is not simply dumped offshore or reinjected into the well is brought to shore and discharged. The U.S. Fish and Wildlife Service, and others, have expressed repeated concern about these practices:

> The Fish and Wildlife Service is concerned that current petroleum industry discharges are causing serious degradation of waters, wetlands, and associated fish and wildlife resources throughout Louisiana's wetlands.[78]

There is little understanding about the consequences of dumping this quantity of toxic produced water in marine and terrestrial natural systems. An example of the information void concerns the presence of radioactive materials in oil and gas well production streams that, until several years ago, was largely ignored, and is still unregulated on a national level (see Box 3: Orphan Wastes).

Air Pollution

Drilling rig engines emit large quantities of pollutants themselves. For example, the MMS estimates that one offshore drilling rig produces daily emissions equal to 7,000 cars each driving 50 miles a day.[79] Oil and gas industry activities on Alaska's North Slope emit 9,000 to 27,000 tons of nitrogen oxides annually, roughly equivalent to the annual emissions from Washington, DC.[80]

The state of California and the county of Santa Barbara have battled for years to compel the federal government to enforce stricter air emission standards on offshore oil and gas activities off the California coast. Finally, in response to a mandate of the Clean Air Act Amendments of 1990, the U.S. EPA formulated new requirements for the offshore industry in October 1992. The new rule allows states to impose their stricter air emission regulations on offshore drilling, even when it occurs in federal waters out to 25 miles. That is good news for California, where substantial reductions in nitrogen oxide and volatile organic compound emissions can now be achieved from the existing 23 offshore platforms.[81] However, the U.S. EPA exempted the entire Gulf of Mexico offshore producing region from the new rule, thus allowing thousands of oil and gas-producing rigs there to continue operating under the more permissive emission standards.

Land and Water Use

Support facilities, tank farms, and moorage preempt valuable port space and land. Rigs both on- and offshore, production platforms, and support facilities all deplete fresh water supplies to a degree that sometimes allows salt water intrusion into fresh water aquifers in coastal regions (this problem can be exacerbated by land subsidence caused by draining oil and gas fields in coastal regions). These activities also contaminate fresh water by land-spreading and road-spreading of toxic drilling wastes, which then percolate into water aquifers, streams, and rivers.

For example, as a consequence of U.S. tax credits for coalbed methane production, a surge in coalbed methane production in the U.S. southwest caused widespread methane contamination of alluvial ground water. Additionally, coalbed methane production results in particularly large volumes of produced water, leading producers to shortcut usual disposal methods and use U.S. EPA-authorized "treatment-based surface-water" discharge.[82]

Wetland Loss and Contamination

According to the state of Louisiana, OCS oil and gas development alone through the year 1978 caused the loss of between 21,863 and 49,884 hectares (54,000 to 123,200 acres)

of wetlands in coastal Louisiana.[83] No definitive figures are available for the loss of wetlands since then, although the rate of loss from all sources is reported to be 50 square miles a year.[84] Many of the remaining wetlands are contaminated and networked with pipelines.

In Texas, the U.S. Fish and Wildlife Service has documented "severe degradation" of wetlands. Oil and gas industry activities have resulted in annihilation of benthic marine life. In one area, the vicinity of Tabb's Bay, it was found that "...sediments contained no benthic fauna."[85]

On Alaska's North Slope, 9,400 wetland acres have been consumed by industry roads and pads, and 3,400 acres of wetlands have been flooded in the Prudhoe Bay unit alone.[86] (Although North Slope gas is now used for reinjection to enhance oil recovery, industry has indicated it will be ready to market the gas after the year 2000.)

Socioeconomic Consequences: The Boom-Bust Cycle

The catastrophic economic bust in the Gulf of Mexico has precisely paralleled the decline in oil and gas production. This crash has debunked what remained of the fragile myth of petroleum industry-generated employment security.

According to the state of Louisiana in response to new offshore oil and gas drilling proposed by the U.S. Interior Department:

> Massive cyclical employment due to unplanned and unsustainable development of on-shore infrastructure [related to OCS activities]...leads to the acquisition of esoteric skills not useful after the bust and population shifts.[87]

Industry and MMS representatives would be unlikely to acknowledge the truth of that statement publicly, but in their more esoteric publications, they clearly do. Contained in the *1991 OCS National Compendium* is a description of the decline in petroleum support industries and a recognition that "many of the support industries had to implement survival policies...company staffs were reduced and company stockpiles of goods were allowed to reach low levels."[88]

MMS expressed the concern that when (or if) exploration and production activities pick up, industries will "be reluctant to produce large stockpiles of goods without sufficient compensation and assurances that this higher level of activity will continue...[and] specialized personnel shortages are also beginning to show. The technology has changed somewhat since the early 1980s and it is going to take time to train people to use the new technology."[89]

In other words, those individuals who lost their livelihood in the late 1980s already have outdated skills, even if there is a resurgence in drilling activity in the Gulf states. After unemployment rates of 4 to 5 percent for decades, some coastal parishes now experience 20 percent unemployment.[90]

This type of devastating economic bust has always followed in the wake of the oil and gas industry. It is inevitable. Jobs that process a finite resource are themselves also finite by definition.

The boom-bust cycle follows a predictable pattern: Individuals are trained for highly technical, explicit functions; communities abandon traditional (and sustainable) economic activities for lucrative petroleum industry jobs. Once the non-renewable resource is extracted and industry moves on to new fields, the region and the people are left with the gutted shell of an industrial infrastructure, no sustainable economic activity, and usually the loss of renewable resource bases due to pollution and the physical impacts of industrialization.

Alaska: The Next Bust

Economists, sociologists, and political planners in Alaska have grappled for a decade on how to deal with the inevitable bust

awaiting the state after the petroleum industry moves on. Seldom a week passes in Alaska where one does not see articles with titles such as "State Readies For Life After Oil Goes," or "What to Do When the Oil Runs Out,"[91] but there are no ready answers. Once a region decides to accept the petroleum industry, it must eventually face the ultimate bust.

Under Governor Wally Hickel's administration, the state of Alaska has proposed a means to forestall the awaiting bust: the Trans-Alaska Gas System (TAGS). Hickel and others hope construction of TAGS will prolong Arctic production of both oil and gas and encourage expansion of production into the offshore and the Arctic National Wildlife Refuge. The project includes laying a new natural gas pipeline alongside the existing Alyeska oil pipeline to bring gas produced on the North Slope south to Valdez. They will construct a liquefaction plant in Valdez to liquefy the gas, which will then be shipped to East Asia via tanker, the environmental hazards of which are chilling.

But even mega-projects such as TAGS will, at best, delay the inevitable bust by another decade or two. During that time, if the state of Alaska does not turn its attention from huge extraction projects like TAGS, the search for sustainable employment opportunities will continue to languish.

Cumulative Impacts

More difficult to quantify, but no less significant, are cumulative impacts of heavy industrialization: the noise from rigs, support equipment, and seismic survey arrays; increased vessel and air traffic offshore, truck and rail traffic onshore; degradation of aesthetic qualities of land- and seascapes and thus deterioration of tourist industries—the list goes on.

The introduction of heavy extractive industry, with all its noise and stench, physical disruptions, and polluting events, can irreparably transform places and the people and wildlife living there.

Chapter Five

Impacts of Processing and Transporting Natural Gas

Processing

Natural gas processing facilities generate a variety of negative impacts on the local environment. Gas processing plants convert raw gas into sales-quality gas, heavier gas liquids, propane, butane, and sulfur in a mix determined by the particular characteristics of the raw gas. These are all hazardous materials. According to the county of Santa Barbara—site of extensive processing of natural gas—the "hazard footprint" (area around accidents within which unacceptable impacts may be suffered by the public) of a gas processing facility can encompass a radius of more than one mile.[92]

The Santa Barbara county guide for siting gas processing facilities lists the following hazards that can result from the accidental release of gas:

- Thermal radiation resulting from ignition and burning of the release or subsequent vapor cloud. This hazard applies to raw gas, processed gas, and gas liquids as well as sulfur and other chemicals used as agents in processing.
- Effects of explosion (including overpressure and fragmentation of the release, subsequent vapor cloud, or material contained in a vessel.
- Direct flame exposure.
- Toxic effects if the release contains significant amounts of hydrogen sulfide or if the incident involves burning sulfur.[93]

Other impacts of the facilities include production of liquid effluent, flaring of sour gas (hydrogen sulfide release), emissions of nitrogen and sulfur oxides as well as methane leaks, physical impacts from construction activities, contamination of surface water, and excessive demands on fresh water supplies. The latter is of particular concern, as gas facilities require an estimated 25 acre-feet to 180 acre-feet of water annually.[94]

See Box 3 (Orphan Wastes: Radioactive Contamination of Natural Gas) for a discussion of the newly recognized problem of radon and radium contamination in the natural gas industry, one consequence of which is the unregulated accumulation of radioactive sludge in gas liquid processing plants.

Ammonia is often used in selective catalytic reduction processes to remove nitrogen oxides emissions (which is, incidentally, true as well for power plants and compressor stations that combust natural gas). Significant quantities of this highly toxic substance are used and must be disposed of properly.

Visually, gas processing facilities are described as having "a profile more obtrusive than that of an oil processing facility."[95]

Transportation

Transportation of raw gas (unprocessed), sales gas (processed) and gas by-products poses public safety risks and generates a broad range of environmental impacts.

Bringing raw gas from the producing field to the processing facility can be particularly hazardous because of the presence of hydrogen sulfide (often present in significant quantities with natural gas and oil in the reservoir). Vapor clouds formed from raw gas leaks or ruptures can be explosive, and the vapor cloud will be highly toxic if it contains hydrogen sulfide (classified as an "extremely hazardous substance" by the U.S. EPA, hydrogen sulfide is five to six times more toxic than carbon monoxide).[96] According to the Michigan Department of Public Health, "One breath of air containing as little as one-tenth of one percent [of hydrogen sulfide] can instantly paralyze the respiratory system."[97] The Michigan report lists a series of deaths and injuries resulting from "serious hydrogen sulfide incidents in the Michigan oil and gas industry."

Pipeline Impacts

Sales gas is transported either by pipeline, or liquified and shipped by liquid natural gas (LNG) tankers. Construction of gas pipelines can generate significant adverse impacts over large geographic regions. For example, in response to an environmental impact statement prepared by the Federal Energy Regulatory Commission for approval of a large pipeline project to bring additional Canadian gas from Alberta to California markets, the U.S. EPA noted:

> ...the proposed pipeline alignments would cross 302 acres of wetlands; 463 perennial and intermittent streams; 26 major rivers; 5 bodies of water with contaminated sediments; 38 recreation fisheries, 31 fishery spawning areas; and 18 anadromous fisheries. In addition, it is projected to potentially affect 31 threatened and endangered species and to disturb large acreages of forested land, sensitive soil areas, farmland, and wildlife habitat. Compressor stations and venting could contribute to air quality degradation. Several hundred significant cultural resource sites would also be crossed.[98]

The magnitude of potential impacts is substantial when one considers the number of such projects underway. A survey by Enron (one of the largest natural gas pipeline companies in the United States) revealed that new pipeline construction in process in the United States as of October 1991 totaled 8,500 miles.[99]

Unfortunately, this expansion is occurring at a time when the Bush administration's National Energy Strategy has recommended a streamlined process for permitting new natural gas pipeline projects. The draft environmental impact statement for the project described above was rated "EO-2, Environmental Objections, Insufficient Information," by the U.S. EPA.[100] Under National Energy Strategy recommendations, the role for U.S. EPA consultations during the review process for natural gas

pipelines and facilities could cease altogether or become a mere token gesture: "The Administration supports legislation making FERC [Federal Energy Regulatory Commission] the sole agency responsible for preparing an environmental impact study for natural gas pipeline construction."[101]

Until the final hour before passage of the National Energy Policy Act of 1992, the bill contained a provision that would have codified weakening of rules to assess the environmental impacts of pipelines and facilities before they occur. That provision was ultimately defeated, but the weakening of environmental oversight lives on in a piecemeal process on the rule-making level. As expressed by the Interstate Natural Gas Association of America, although provisions to streamline pipeline construction were deleted from the energy bill, "we know FERC [the Federal Energy Regulatory Commission] is implementing many of these procedures and we encourage them to continue to do so."[102] In the future, the U.S. EPA may not have the opportunity to ride herd on such ill-conceived, poorly mitigated proposals.

In the lower 48 states, an extensive pipeline infrastructure is in place for transportation of natural gas. Most new construction will consist of expanding and interconnecting the existing system and, as a consequence of the North American Free Trade Agreement, increasing capacity from Canada and into Mexico. This is not the case for Alaska and most Pacific Rim countries, where ambitious plans are under way to create an interconnected natural gas infrastructure that will essentially encircle the North and Equatorial Pacific with pipelines, processing plants, natural gas refineries, LNG facilities, and tankers.

Although the use of natural gas as fuel is not thought to necessarily pose a greater safety risk than either gasoline or hydrogen (as in the fuel tank of an automobile),[103] there are a growing number of pipeline incidents resulting in serious accidents, a factor of an aging infrastructure. According to the U.S. General Accounting Office:

> Each year several hundred pipeline incidents (i.e., ruptures and leakages) occur [in the U.S.], often resulting in deaths and damage to property or the environment. Since most natural gas pipelines were constructed in the 1950s and the 1960s, the risk of damaging incidents in these aging pipelines will only increase.[104]

Despite this increasing risk, since 1985 the number of pipeline incident reports submitted by natural gas operators to the U.S. Department of Transportation has sharply declined, but only because weaker federal reporting requirements were implemented at that time.[105] Yet, in the years 1985 to 1991 there were still 1,726 incidents reported, resulting in 131 fatalities and 634 injuries.[106]

Floating Bombs

LNG conveyed by tanker is undeniably hazardous. According to the Northwest Alaskan Pipeline Company, "Potential LNG emergency incidents in the past have been viewed as events with a low probability of occurrence but a high probability of major damage."[107] The U.S. Coast Guard concurs with that assessment. In Boston Harbor, for example, Coast Guard regulations permit LNG tankers to transit the harbor only between the hours of sunrise and sunset, and then only during periods of adequate visibility. All other vessels in the harbor must be moored as the tanker passes in a "moving safety zone," unless given express permission by the Coast Guard (tugs accompanying the tanker, for instance). The safety zone even extends vertically, as the Federal Aviation Administration imposes flight restrictions over the vessels. Nothing moves but the LNG tanker.[108]

The following is a description of the effects of an LNG spill from the Northwest Alaskan Pipeline Company:

> LNG released into the atmosphere will vaporize as it absorbs heat from the surroundings. It will then burn if diluted with the proper amount of oxygen and if exposed to an ignition source. Until both conditions are met, a flammable and highly toxic vapor cloud will continue to be formed until the LNG is completely vaporized. The cloud will enlarge and travel downwind until it is dissipated by further heating or by turbulence in the atmosphere.[109]

The gravest concerns, of course, are the size of the vapor cloud and how far it will travel in a "radius of flammability." Postulating several different release scenarios for the TAGS LNG facility to be built at Anderson Bay in Valdez, Alaska, it was calculated that a 10-minute release into the water from a loading arm to a tanker would release 120,000 gallons with a resultant flammable/toxic cloud extending a maximum distance of 11,920 feet with maximum width of 9,120 feet.[110] (Loaded supertankers carrying North Slope crude pass within 7,595 feet of the postulated loading arm.[111]) Not calculated are scenarios involving greater spillage, for instance the consequences of rupture of an LNG carrier's cargo tanks, which carries 6.5 million gallons of LNG.[112]

Despite these and other safety concerns, the National Energy Strategy also recommended "an expedited environmental procedure for siting of major energy facilities, including LNG plants."[113]

Chapter Six

The Reality Behind the Greenwash: The Future of Natural Gas

Precedents from the Past

If there is anything we should have learned from the history of global politics during the last five or six decades, it is a recognition that the major oil producers have manipulated and engineered global energy markets, the geography and demography of industrial expansion, and international politics, including war. Since the oil shocks beginning in 1973, and more recently, the Persian Gulf War of 1991, it is an isolated individual who does not have at least a notion of the enormity of global oil power.

Petroleum's success as the dominant world energy source was ensured by locking in a stable balance of supply and demand through a process of:

- identifying hydrocarbon-prone basins;
- acquiring leases for exploration and development;
- expanding the production and transportation infrastructure;
- guaranteeing a favorable marketplace with prices high enough so development and production are profitable, yet low enough to exclude other energy sources.

In the United States, the latter was accomplished with the aid of government subsidies and a sophisticated, no-expense-spared marketing strategy. Until recently, there was no particular motivation to invest an equivalent level of expense and effort into delineating and acquiring gas reserves or marketing gas; although occasional global crises sent oil prices haywire, oil has been plentiful and "cheap" for decades.

Only in recent years, as easily produced U.S. oil reserves dwindle; as increasingly stringent environmental regulations are demanded as a consequence of such incidents as the *Exxon Valdez* spill; and as concern mounts over urban smog, acid precipitation, and global climate change, has there been a recognition that continued exclusive reliance on oil as an energy source cannot continue. This recognition comes not only

from the public and political sectors, but also from the oil and gas industry, who increasingly look to expansion of the market share for gas. According to the *1991 International Petroleum Encyclopedia*:

> Whatever the enormous challenges and pitfalls awaiting the petroleum industry in the Decade of the Environment, there is little doubt about one thing: natural gas has a bright future in the 1990s...environmental and energy security concerns together dictate that natural gas is an energy source whose time has come...And the gas industry has the environmental movement to thank for that.[114]

The Face of the Industry

It is relevant to note that the top seven producers of natural gas are Chevron, Amoco, Texaco, Exxon, Mobil, ARCO, and Shell.[115] The major transnational oil and gas corporations produce more than 50 percent of U.S. natural gas.[116]

Many smaller, independent producers also typically produce both oil and gas. A spokesperson for the Independent Petroleum Association of America stated:

> "Since oil and natural gas reserves typically can be found near each other, most oil companies also produce natural gas. Many industry officials say they hope the oil industry will be able to depend on a boom in the gas market to protect it from financial disaster."[117]

The petroleum giants are also concerned about the impending demise of the "Oil Era" and hopeful that gas will pull the industry out of the doldrums.[118]

One of the industry's most ardent advocates in Congress, Senator Bennett Johnston, Chairman of the Senate Energy Committee and principal author of the National Energy Policy Act, commented in 1992 that the oil business is a "very, very sick industry," but added that the same industry is also the gas industry, and that his comprehensive energy bill will do more for natural gas than for anything else.[119]

At the annual "state of the industry" hearing in March 1992, speakers described the petroleum industry as "on the verge of collapse," and complained that "federal and state governments [must] take decisive action and use their clout to make natural gas the preferred fuel for industry and electrical power generation."[120] Judging from new legislative mandates, and state and federal rule-making outlined below and in Chapter 2, the oil industry should be gratified.

A Stable Market in the Making

Natural gas expansion in the United States and elsewhere has historically been stymied by an inability to satisfactorily effect a stable marketplace for a fuel that suffered from a reputation of unreliable supply and high cost. That situation is quickly changing with multi-layered federal and state actions that will establish the ideal scenario: a stable supply-demand balance that will enable a steady, gradual rise in the market cost of methane.

On the federal level, the National Energy Strategy outlined an aggressive plan to deregulate natural gas pipeline services, a plan now being implemented by Federal Energy Regulatory Commission. The National Energy Strategy also proposed removal of "unnecessary regulations" on natural gas imports and exports, a directive codified in the National Energy Policy Act of 1992 and the NAFTA. The National Energy Strategy also encourages production in the Outer Continental Shelf (OCS), from Alaska's Arctic Ocean to the deep waters of the Gulf of Mexico. Congress approved the new five-year plan for development of the OCS in July 1992.

Gas-producing states in the South are correcting a temporary over-supply of natural gas by altering their "pro-rationing" rules to hold down gas production long enough to "burst the gas bubble" and permit prices to slowly rise. This has largely been accomplished. This pro-rationing, dubbed the "Bubba Cartel," has been harshly criticized in congressional circles, but there has been no national action to halt the practice.[121]

Additionally, the U.S. Department of Energy (DOE) launched a project to eliminate state barriers to natural gas use. They are examining state regulatory impediments to natural gas development and state barriers to gas consumption.[122]

The industry itself has not been idle. It has formed alliances between different sectors of industry, with the U.S. DOE, utility regulators, and even with some renewable energy industry representatives (the latter are understandably grateful for any support after a decade of neglect from the Reagan/Bush administrations), as well as some of the major environmental groups. An industry journal recently reported:

> Natural gas producers in the U.S. have something to cheer beyond the recent apparent rebound in their commodity's price: Important parallel efforts are under way to ensure long term gas market growth. The Interstate Oil & Gas Compact Commission (IOGCC) and the U.S. DOE "have taken the supply security issue straight to the people who need it," the National Association of Regulatory Utility Commissioners (NARUC), by proposing that NARUC undertake a study of gas issues with an offer from IOGCC to help them. "The IOGCC considers gas so important to its member states' fortunes that it recently added the word 'gas' to its name." (Until recently, it was the Interstate Oil Compact Commission, IOCC.)[123]

Similarly, industry has created the "U.S. Gas Council," composed of 26 members from the oil and gas industry, and chaired by Chuck Joran, Vice President of Chevron USA Production. The Council announced it intends to stimulate an increase in U.S. gas demand of 2.5 trillion cubic feet annually by 1996 and develop "Council-run environmental initiatives that would stress the benefits of natural gas over other fossil fuels with coordination with environmental organizations and the EPA."[124]

All these efforts have paid off: the price of gas is indeed recovering and expectations are high for a stable supply-demand balance.[125] This creates a closed loop in which existing transportation infrastructure helps solidify the market and justify more exploration and development, which leads to greater production, need for more pipeline infrastructure and processing facilities, and so forth—all with the support of visible and non-visible government subsidies. This supply-demand marketing almost incidentally excludes clean energy alternatives from the marketplace.

The recovering health of the upstream gas industry has helped also revive the entire petroleum drilling industry. Enthusiastic statements such as "Natural gas continues to lead the U.S. petroleum industry's faltering climb out of the doldrums,"[126] have commonly appreared in industry journals since September 1992.

The world may never again see the likes of the global reign of the "Seven Sisters," but the sum of regional energy market manipulations will have powerful consequences for the world's energy mix. Trade agreements are effecting borderless movement of energy sources within specific regions. If the industrial countries choose another fossil fuel to dominate the new energy mix, will less-industrialized countries locked into trade agreements be able to resist? The NAFTA, for example, sanctions subsidies *only* for oil and gas development.

Chapter Seven

Projected Supply and Demand of Natural Gas

Proven Reserves and Estimated Recoverable Resources

As with oil, the United States holds a relatively small percentage of the world's proven natural gas reserves, less than 4 percent (see Figs. 2 and 3).[127] Total world reserves as of January 1, 1993, were 4,378 trillion cubic feet (tcf), of which the United States has 167 tcf.[128] With annual U.S. consumption at about 20 tcf, the reserves:production ratio for U.S. gas is about 8 years. Even considering the addition of Canada and Mexico's proven gas reserves via the NAFTA, all of North America holds only 8 percent of the global gas reserves, or enough for 16 years at current rates of consumption (see Fig. 2).

Historically, exploration for hydrocarbons has concentrated on oil rather than natural gas. Now that the focus is shifting to gas, the estimated recoverable resources worldwide (not reflected in proven reserve statistics) will be quickly delineated and moved to proven reserve figures. In the South China Sea, Siberia, the Arctic, the Mexican Gulf of Mexico, the Amazon Basin, and elsewhere, significant quantities of natural gas await definition by the rapidly expanding industry.

The United States will also yield greater quantities of recoverable natural gas as the focus shifts, but there is no geological province in the world more explored than the United States,[129] and the potential for discovery of large fields is much less likely than in the less-explored regions of the world. There are still undefined resources of natural gas in the United States estimated at 1,000 to 1,200 tcf,[130] or enough to last 60 years at current consumption rates.

Worldwide, estimates vary as to the ultimately recoverable natural gas resource base, but most are optimistic. According to a current assessment reported in the November 1992 volume of the *Oil and Gas Journal*: "Considering the prospects for new natural gas discovery, the world gas reserves-to-production ratio is expected to exceed 100 years by 2000 and will still be

about 80 years in 2020."[131] The current reserves:production ratio is about 59 years.

Most global and domestic estimates of potential resource recoverability do not incorporate the enormous quantities of "unconventional" natural gas, such as that contained in tight sands, Devonian shale, coalbed methane, and offshore geopressured areas (deep gas), which could total an additional 4,900 tcf globally.[132] Additionally, huge deposits of methane are locked in ice in the world's polar regions and elsewhere; known as methane hydrates, they are estimated to contain between 500 tcf and 1,200,000 tcf of natural gas,[133] which could increase today's proven reserves by a factor of 275, or enough to last 16,500 years at today's rate of consumption.

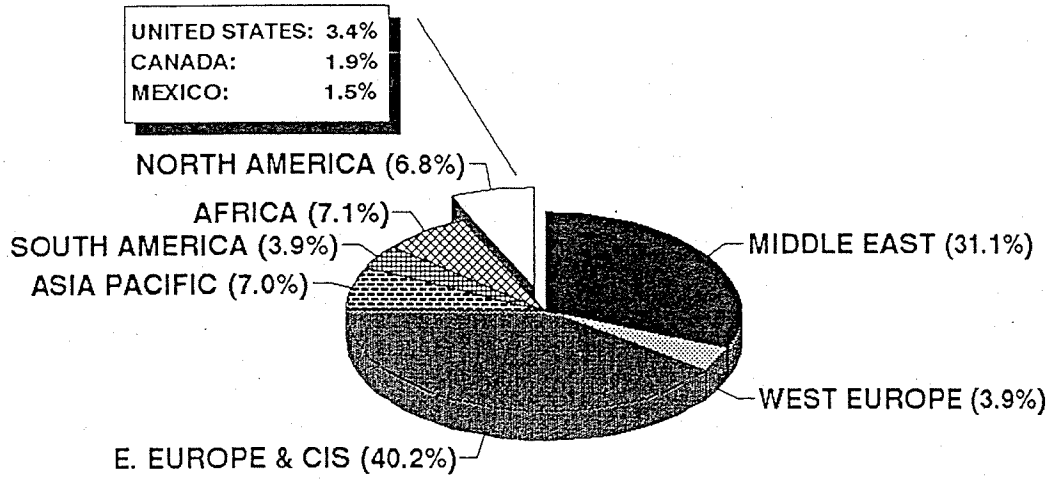
Unconventional methane extraction is much costlier and more technologically challenging than conventional recovery. The price of gas would have to escalate markedly and/or magnanimous government subsidies would be required for exploitation. (The latter will be encouraged by the ratification of the NAFTA, which specifically sanctions government subsidies for natural gas and oil and no other energy sources.)

The environmental hazards of unconventional methane extraction are also proportionately greater. Until recently, many assumed the extraordinary hazards associated with production of methane hydrates would at least ensure that this particular fossil fuel would remain underground, but industry and the U.S. DOE are aggressively pursuing research and development for their eventual production in the early decades of the next century.[134] Similarly, U.S. DOE is pursuing plans to produce the large volume of gas believed to be contained in deep sediments of the ocean bottom.[135]

As mentioned, ratification of the NAFTA, and pending agreements with the other

Figure 2

WORLD RESERVES OF NATURAL GAS BY REGION

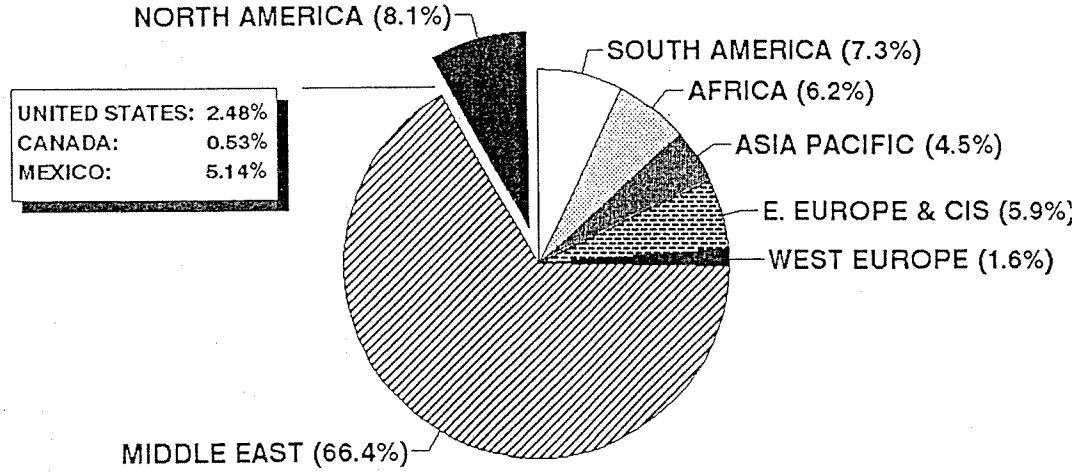


TOTAL WORLD RESERVES = 4,885 TRILLION CUBIC FEET
(AS OF JANUARY 1, 1993)

SOURCE: OIL AND GAS JOURNAL, December 28, 1992, pages 44-45.

Figure 3

ESTIMATED WORLD OIL RESERVES BY REGION



TOTAL WORLD RESERVES: 997.0 BILLION BARRELS
(AS OF JANUARY 1, 1993)

SOURCE: OIL AND GAS JOURNAL, December 28, 1992, pages 44-45.

countries of the Western Hemisphere, would create a borderless pool of natural gas for the hemisphere. Such accords not only free up the reserves of other countries for U.S. use, but also facilitate development of otherwise uneconomical supply projects (such as development of Arctic methane and the deep offshore) by allowing powerful transnational corporations to share risk in exploration and development, and by ensuring that a long-term, stable market will be in place to receive the product.[136]

Although there is less than a decade of proven gas reserves in the United States, the potential resource available for U.S. consumption is very large, provided there is continuing demand and a stable marketplace. The assertion that natural gas will simply be a bridging fuel to carry us to a more politically acceptable moment in time for renewable energy systems is unlikely. Once the market is firm and infrastructure is in place for methane production and distribution, we will be committed to decades of continued fossil fuel consumption and its environmental and social liabilities.

Forecasts for the Short and Medium Term

The Energy Information Agency (EIA) predicted in early 1992 that the use of natural gas would increase at a proportionately greater rate than any fuel in the next 15 years, providing an increasing share of the global energy mix from a current one-fifth to a projected one-fourth by the year 2010.[137] The EIA predicts the growth rate will approximate 3 percent annually in less-industrialized countries, 2 percent for the OECD countries as a group, and 1 percent for North America.[138]

Compared with other estimates and real-world events, this forecast is very conservative. From 1986 to 1991, U.S. natural gas consumption increased by 25 percent, and an additional 5.5 percent growth is forecast

for 1993 by a more recent EIA report. Even during the past recessionary year, U.S. gas use expanded by 3.8 percent, after a 5.9-percent increase in 1991.[139]

As mentioned, the U.S. Gas Council has vowed to effect an annual growth rate of 2.5 tcf (or about 10 percent) by 1996. This is quite feasible, given the rapid expansion of natural gas in electricity generation and transportation, recently mandated national subsidies and incentives, and the virtually ubiquitous endorsement of natural gas as a desirable fuel.

The Canadian Energy Research Institute released a two-year study in September 1992, predicting worldwide gas output would double by 2015.[140]

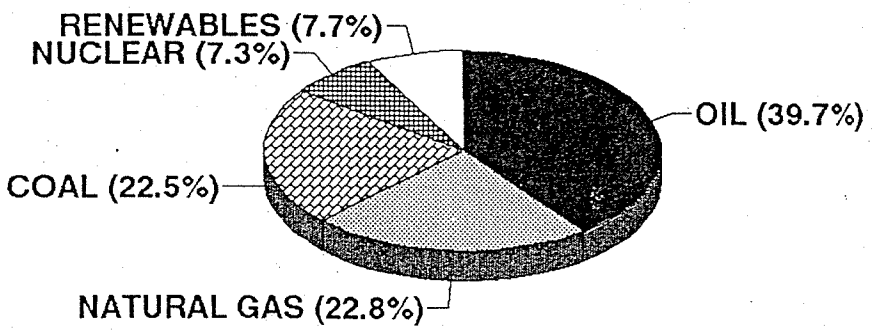
In today's rapid growth pattern, the limiting factor for the United States will not be demand, but getting the methane out of the ground and transporting it quickly enough to fill swelling demand. The days of excess supply, of the "gas bubble," are becoming history.

Infrastructure to produce, transport, and distribute natural gas is essential for creation of a stable marketplace and access to new fields. This is why the petroleum industry has been willing to continue expansion of pipeline and processing facilities even in the face of the slumps of recent years. As expressed in the *Oil and Gas Journal*:

> From the producers' perspective, basins that currently are transportation-constrained...will have more buyers bidding for supplies and fewer producers with shut-in gas when pipeline capacity is increased...As a result, this increased access to markets will contribute to higher prices in that basin relative to what they would have been without the additional market access.[141]

Figure 4

UNITED STATES ENERGY CONSUMPTION BY TYPE



TOTAL U.S. CONSUMPTION = 85 QUADRILLION Btu (1990)

SOURCE: Interpreted from data presented in: Energy Information Administration, "1992 Energy Outlook," DOE/IEA-0383(92)

Their tenacity has paid off, as the price of natural gas exhibits a much healthier growth rate than predicted; in 1992 prices more than doubled in six months.[142] The actions of pro-rationing states from the "Bubba Cartel" were partly responsible, but the real turning point was Hurricane Andrew's rout of offshore facilities in the Gulf of Mexico. The oil and gas industry sustained billions of dollars of damage to their offshore platforms and pipelines, but the temporary loss of gas production seemed to shake-up the market at precisely the right moment to give a leg-up to the upswing in wellhead prices.

Pipeline capacity to move Canadian gas to the United States is expanding rapidly to satisfy the new demand. If new capacity comes on-line as planned, Canadian export capacity to the United States will increase by 34 percent from the 1992 level.[143] In the last two years, imports from Canada have grown by 32 percent, with another increase of 8.3 percent predicted for 1993.[144] Canada exported over 2 tcf of gas to the United States in 1992,[145] a level of export that the EIA's *1992 International Energy Outlook* had predicted as the leveling off point for the *late* 1990s.[146]

The Gas Research Institute (GRI) reports liquid natural gas imports are also on the rise. After a shutdown of LNG terminals in the recent past, GRI predicts that all existing U.S. LNG terminals will be in use by the mid-1990s, and new facility capacity and tankers will be required.[147]

Simultaneously, the United States has expanded its natural gas exports to Mexico by 390 percent in one year.[148] Ratification of the NAFTA will accelerate movement of natural gas all over the continent.

Natural Gas and "National Security"

Although the United States has less than 4 percent of proven global natural gas reserves, the U.S. DOE and other industry proponents portray the switch to natural gas as a "national security" issue. We should use more natural gas to decrease oil imports, it is said, although the United States's share of world oil reserves is also less than 4 percent (see Figs. 2 and 3). The Bush administration's National Energy Strategy addressed this arithmetic reality as follows:

> ...production of natural gas will rise substantially over the next few years in response to higher demand over the next 20 to 30 years. However, in the long run, it is expected that low-cost natural gas resources will be depleted. Consequently, even as natural gas production rises, long-term prices for this fuel are projected to rise rapidly and make possible exploitation of very large higher cost resources in tight sands and other unconventional sources that are known to exist...[and] U.S. production of natural gas from existing areas of development is expected to be supplemented by the introduction of natural gas from Alaska's North Slope (starting in 2005).[149]

Unfortunately, the U.S. DOE does not factor into this argument the fact that the same process will occur on an international scale: other countries will simultaneously expand their unconventional gas resource base as prices rise, and the proportionate rise of U.S. reserves will probably never be much above the current 4 percent. Free trade accords such as NAFTA and the Enterprise for the America's Initiative will facilitate U.S. access to natural gas resources in Canada and Latin America, but the entire Western Hemisphere only holds 11 percent of world gas reserves.[150]

Although hydrocarbon basins prone to a greater gas than oil mixture are more evenly distributed around the planet than oil, the fact remains that most of those basins lie in the Middle East and former Soviet regions, as is the case with oil (see Fig. 2). The for-

mer Soviet Union and Eastern Europe hold 40 percent of global natural gas reserves; the Middle East has 31 percent.[151]

Where Have We Heard This Before?

In a disturbing parallel with the existing geography and production:supply ratio of oil, we note that Iran, for example, possesses 14 percent of current proven reserves of natural gas and accounts for only 0.8 percent of global production. In contrast, the United States, with a mere 4 percent of current proven reserves, produces 24 percent of the world's gas.[152]

We see a familiar pattern unfolding.

1) The United States is creating a political climate and a biased energy market that will guarantee dependence on a finite, polluting energy source that is a significant contributor to global warming and pollution.

2) The United States has less than 4 percent of known reserves of that energy source.

3) In order to expand our reserves:

- Subsidies will be offered to encourage unconventional recovery (which will exacerbate environmental consequences of recovery and impede marketable renewable energy systems);
- Pressure will mount to allow development of fragile wilderness areas, the Arctic, and offshore regions.

4) As the Unites States depletes its reserves over the next decades, imports by hazardous tankers will increase from politically unstable regions of the world.

Painful as this is to observe in the United States, where we should have learned from the lesson of oil dependence, it is even more troubling to realize the consequences for less-industrialized countries. The energy choices they make today that will determine energy use patterns for decades.

Many countries struggling to expand their economies are already burdened by national debts incurred for fossil fuel development and/or import. If the industrialized North gains access to the fossil fuel resources of the less-industrialized South through free trade accords, the obstacles to non-carbon energy production and energy efficiency improvements in those countries will be enormous.

The implied assumption in U.S. energy policy—and accords such as the NAFTA—is that energy security means increasing energy supply. If the fundamental goal of long-term energy planning were instead to thoughtfully address genuine energy security, the focus would be on rigidly conserving the supply of finite fuels—fuels that impose enormous environmental and social costs. Genuine energy security should describe a situation wherein adequate energy sources are available to meet all peoples' needs, and the energy should be in a form that endures and will not degrade the local and global environment. But the notion that more must be better continues to force energy policy decisions toward increasing supply rather than decreasing demand for natural gas, as it has for all fossil fuels.

The Long Term

A frequently cited justification for increased natural gas use is that it can replace oil and coal, the "dirtiest" of the fossil fuels, and thereby reduce air pollution and global warming emissions.

Worldwide, gas reserves are larger than oil. Oil supplies will last 43 years at current rates of consumption; proven gas reserves would last 60,[153] and as mentioned, concerted exploration for methane-prone basins has just begun. It is thought that the total recoverable conventional global natural gas base will last 120 years at current rates of consumption.[154] If natural gas is substituted for coal in all applications (and if production of the much larger resource of unconventional natural gas does not become economically feasible) the total re-

source could be exhausted within 55 years.[155]

On the other hand, there is enough economically recoverable coal in the world to last 1,500 years.[156] The United States' huge coal reserves—240 billion tons—are 23 percent of the world's total[157] and are sufficient for centuries of unrestrained consumption. The presence of this enormous coal resource is often overshadowed in the ongoing preoccupation with oil and gas, but at the heart of long-term energy planning within the U.S. DOE and the fossil fuel industry, it figures prominently. Development of "clean coal" technologies has long been on the front burner for research and development priorities with the Reagan/Bush administrations, and now with the Clinton administration as well.

In a discussion of the problems with adequate, cost-effective clean coal technologies, a solution is defined by the petroleum industry:

> ...[as] a happy compromise and [one that will] provide a wonderful marketing opportunity for the gas industry: co-firing...Plants can operate at full capacity and stay within air quality standards. At the same time, co-firing enables a plant operator to switch to lower quality costs, rein downtime, improve combustion efficiency, and cut maintenance of downstream equipment...access to gas won't prove a problem for most power producers that need it for co-firing...the top 100 emitters of sulfur dioxide in the U.S. are an average 5 miles from one or more gas pipelines...[158]

(Co-firing combines natural gas with coal in the combustion process in usual proportions of 10 percent natural gas, 90 percent low or medium sulfur coal.[159])

Convincing the coal industry of the benefits of co-firing is a high priority for the American Gas Association, and they have presented convincing arguments such as the following:

> ...where gas enjoys a cost advantage, it's always because sharply lower capital and operating costs for its facilities more than cancel out the fact that the fuel itself costs more than coal. But huge capital investments already incurred at a plant built for coal would be worthless with a total gas conversion. This non-amortized investment would have to be added to the gas capital cost. This may inhibit utilities from going all the way with gas repowering; they may settle instead for simply co-firing existing boilers with gas. Gas needs here would be sharply lower.[160]

The National Energy Policy Act of 1992 has codified National Energy Strategy recommendations by instructing the U.S. DOE to embark on a five-year program to enhance development of gas/coal co-firing processes. The use of gas and coal together has also been given an endorsement by the new Clinton/Gore administration. In response to a presidential candidate questionnaire submitted to the Clinton campaign by the Houston-based People for an Energy Policy, Mr. Clinton responded:

> "The Clinton/Gore national energy policy will greatly increase U.S. gas usage for power generation and transportation. This will create jobs, enhance national security and reinvigorate our U.S. oil industry. Coal is an abundant fuel, with over 200 billion tons in the U.S. We must find ways to make high-sulfur coal less polluting when it's burned. That's why the Clinton/Gore plan calls for increased investment in research aimed at developing clean coal technologies like co-firing gas and coal, fluidized coal bed methane, and gasifying coal. Energy independence is our goal. While natural gas has many environmental benefits, we cannot afford to ignore our tremendous reserves of coal. Additional and better research must

BOX 4: Cornering the Utility Markets

According to Blair Sweezey of the U.S. National Renewable Energy Laboratory, renewable energy sources have represented only 12 percent of the total new electrical generating capacity selected in competitive bidding, while natural gas represents 54 percent.[1] This preference for natural gas is largely a reflection of cheap methane, confidence in long-term supply, and the relatively low capital investment required for new combustion turbines.

In the Pacific Northwest, the low price of gas-fired electricity has had the effect of setting an unnaturally low ceiling of "cost-effectiveness" for energy efficiency and renewable energy developments. Energy efficiency and renewable resources alike are generally cost-effective compared to coal and nuclear power, but only the cheapest energy efficiency measures can compete with gas-fired combustion turbine power entering the market at between 2.5 and 3 cents a kilowatt-hour (in real inflation-adjusted dollars).[2]

The Pacific Northwest's Bonneville Power Administration (BPA) is required by federal legislation to pursue conservation costing up to 10 percent more than less desirable alternatives. But in the Northwest as elsewhere, gas-fired plants are dominating competitive bidding processes based on the promise of cheap, plentiful supplies of natural gas. If gas CTs were placed on a level playing field, it would be highly cost-effective for Northwest utilities to include efficiency measures and renewable energy supplies far in excess of what is now being committed to.

The Northwest Power Planning Council reports that even with cheap gas, there are still "huge opportunities to secure all cost-effective energy savings."[3] The issue is whether or not the opportunity will be provided to implement conservation and renewable systems before natural gas corners the market altogether. According to the Northwest Power Planning Council:

> Conservation is also critical now because of the balance of resources that ensures system resiliency. A future where gas supplies a major portion of the region's power needs lacks this resiliency...That gas-dependent future is occurring now.[4]

Renewable energy systems, along with conservation, could provide that future resilience and energy security, but Don Bain of the Oregon Department of Energy believes the opportunity for renewables in the Northwest is closing quickly, with over 90 percent of the 1990s energy resource commitments being made now. "Gas is renewables' competition," Bain says.[5]

Relatively cheap supplies of natural gas are negatively impacting demand-side management programs and domestic renewable energy development in many regions of the United States. In New York, the competitive bidding for new supply has demonstrated that the advantages of renewables are effaced by price penalities resulting from existing tax incentives.[6] For instance, capital investments in new plants are taxed, but plant operations are not. The cost of renewables is primarily concentrated in the construction phase, while operating costs are typically low and fuels costs are virtually zero for the life of the plant. Gas-fired CTs, on the other hand, have low initial capital requirements; most of their cost is associated with operations and fuel.

Thus, gas turbines are favored by existing tax and investment incentives, making them appear more attractive to a utility especially as near-term investments. Swezey reports that since competitive bidding has become the preferred mechanism for utility purchase, "approaches must be developed that can equitably weigh the full range of costs and benefits of generation options."

Investments in energy efficiency suffer from price disincentives as well. Although some energy efficiency savings are cheaper than building new generating capacity and have no adverse effects on the environment, conservation programs reduce a utility's revenues by reducing total sales of kilowatt-hours. Unless price reforms are introduced to decouple profits from the sales of its kilowatt-hours, utilities lose money when they save energy.

If all costs imposed by the total fuel cycle of methane—including global warming impacts—were included in the market price to level the playing field, this takeover of competitive bidding could not happen. For example, the Energy Policy Branch of the U.S. Environmental Protection Agency suggests that a moderate carbon tax ($15/ton in 1990, growing 5 percent annually to $39.80/ton in 2010) would raise the price of natural gas immediately by 14 percent, and by 37 percent in 2010.[7] The price of oil, although it has a greater carbon content than gas, would increase by only 11 and 18 percent, respectively. This seeming incongruity is explained by the artifically low price of gas.[8]

The price of gas has risen steadily in the last two quarters of 1992 and, according to forecasts, will continue to rise more gradually. However, large price spikes and depressions will probably be avoided by the buffering effects of government subsidies, unbundling of pipeline services, market manipulations such as prorationing from gas-producing states, and perceptions of stable supply created by free trade accords. Additionally, gas producers and distributors alike are concentrating on implementation of long-term contracts with buyers to further stabilize the market share and remove any lingering skepticism in utility decisions regarding the stability of gas supply.

According to Jeff Skilling, CEO of Enron Gas Services: "Going back to more long term contracts and relationships can only help our ability to outperform the alternative fuels in the future."[9] Skilling comments that the U.S. gas industry will have to sink enormous investments—in the order of $75 billion during the next seven years—"if we expect the industry to grow." These comments do not sound as though they describe a "bridging fuel," although, ironically, Enron Corporation has aggressively led the oil and gas industry's initiatives to form alliances with many of the individuals and groups who advocate methane as a "bridging fuel."[10]

Notes

1. Swezey, Blair G. "The Current Status of Renewable Electric Generation in the U.S.: Deployment, Economics, and Policies." National Renewable Energy Laboratory. Paper presented to the NARUC-DOE 4th National Integrated Resource Planning Conference, 9/13-16/92.

2. Stump, Ken, and Carol Alexander. *"The North American Free Trade Agreement And Energy Trade."* Washington, DC: Greenpeace, 12/92.

3. Collette, Carlotta. "Natural Gas: Is Today's Bargain Tomorrow's Best Buy?" *Northwest Energy News* Nov/Dec 1992, p.18.

4. Ibid.

5. Bain, Don. "Northwest Wind Power Sales and Siting Issues." Oregon Department of Energy, 1992; Bain, Don. "New Northwest Resources: Gas, or Conservation and Renewables." Draft of 12/23/92, Oregon Department of Energy.

6. Swezey, op. cit.

7. Shackleton, Robert, et al. The Efficiency Value of Carbon Tax Revenues." Draft 11/5/92, pp. 2-3.

8. The price increase depends on the number of energy units per dollar of fuel, and the tons of carbon per energy unit. (Personal Communication from Robert Shackleton, EPA Energy Policy Branch, Nov. 1992).

9. Koen, A.D. "U.S. Gas Industry Sees Signs of End to Lengthy Downtum." *Oil And Gas Journal* 1/13/93, p.15.

10. The Business Council For A Sustainable Energy Future is chaired by Kenneth Lay of Enron and includes representatives from the renewable energy industry as well as environmental organizations such as the Worldwatch Institute. Council members "typically denied that competition was now or was likely to be a serious problem." Sant, Nick . "Natural Gas, Efficiency, Renewables: Allies or Competitors?" *Energy, Economics And Climate Change December 1992, p. 2.*

be targeted at methods for burning coal of all types more cleanly."[161]

Coalbed Methane Subsidies

A marriage of coal and natural gas interests has also been encouraged through federal tax credits (specifically, the "Section 29" credit) that encourage production of coalbed methane. Production of coalbed methane enhances eventual coal production because it removes gas from the coal (reducing the danger of mine explosions) and a portion of the gas can then be used to power and ventilate the mines during production of the coal. It also allows the mining companies to delve deeper into the coalbed and extract more coal.[162] The accelerated methane extraction from coalbeds has left behind a great deal of coal to be produced. The tax credit is split between the coal and gas interests, and production of both resources is phased to proceed at optimum levels.[163]

The Section 29 tax credit stimulated one-third of all new U.S. gas wells completed in 1990 and 1991 (including coalbed and tight sands gas). By the time the credit expires in 1992, a total of 9,000 coalbed methane wells will be added with at least 12 trillion cubic feet of new gas reserves in the United States.[164] In 1991 alone, 3 tcf of coalbed methane reserves were added.[165] Two months before the tax credit was due to expire in January 1993, the U.S. DOE reported that coalbed methane's share of total U.S. gas supplies rose by 29 percent.[166]

Efforts to extend the tax credit beyond 1992 were attempted via the National Energy Policy Act, but defeated. Other provisions of the Act, however, do instruct U.S. DOE to facilitate production of coalbed methane, and separate legislation has been introduced to extend the credit. But even should the credit end as scheduled, industry representatives seem confident that the past few years' activity has allowed development of processes and technology with such promise that coalbed methane extraction will continue to be profitable even without the subsidy. So much so, in fact, that producers are already looking overseas where "profitability could almost be guaranteed in other basins around the world...if a gas market were available."[167]

Unconventional recovery methods sometimes worsen environmental consequences of energy extraction. In the U.S. Southwest, the fracturing of coalbeds to extract methane, and associated leaking well casings, have allowed migration of methane into local fresh water wells. Coalbed methane extraction has also resulted in unusually large amounts of toxic produced water that have been improperly disposed of.[168] When the state of Colorado proposed new rules to help safeguard local drinking water wells, industry resisted.[169]

If coal extraction must continue, it is certainly preferable to capture the methane and combust it rather than allow it to escape into the atmosphere or remain in the coal seams to endanger miners. But the crux of the issue is that we must get beyond production of coal to non-carbon, clean energy alternatives.

Gas and Coal Interdependence

Other examples of the growing relationship between methane and coal producers involve the growth of natural gas turbines and combined cycle power systems.

As mentioned, both the National Energy Policy Act of 1992 and the Clinton/Gore administration have endorsed coal gasification power systems. Under the "Clean Coal II" program, the U.S. DOE funds gasification projects for utility generation and supports research and development efforts with corporations such as Texaco [probably the leader in integrated gasification combined cycle (IGCC) systems that burn gasified coal].[170] IGCC systems are desirable because of their high efficiency, and because they can burn just about any kind of gasified fossil fuel.

According to a General Electric manager:

> "The long-range viability of gas turbine generating systems depends on developing coal as a fuel...[T]here seems to be a widespread feeling that gas turbines in the 21st century will have to burn coal in some form."[171]

Texaco has led the use of coal gasification in IGCC systems, and now has 100 gasification licenses outstanding, with more than 30 applications up and running around the world.[172] Texaco first commercialized gasification in the early 1950s to convert methane into synthetic gas as a chemical feedstock, but "as the relative cost of fossil fuels changed over the years, Texaco examined a wider range of feedstocks from oils to coal, petroleum coke, and even hydrocarbon wastes and found that all of them could be gasified."[173] One gasification project in Delaware is even gasifying petroleum coke, a "bottom-of-the-barrel" refining project.[174]

The journal *Modern Power Systems* reports:

> Many gas-fired combined cycle plants are being installed today, but with gas prices invariably rising as we approach the next century, the coal-fired simple cycle IGCC plant is likely to be the plant of choice.[175]

A similar forecast is to be found in the *Oil and Gas Journal* with an admonition to operators to "set aside the site space for coal gasifiers" at new combined cycle power generating sites.[176]

The U.S. DOE's *1992 Natural Gas Strategic Plan* projects that conventional natural gas supply will level in the year 2005 and then quickly fall, to be replaced by synthetic fuels (from coal, sands, and shales), expanded imports, and "speculative resources" beyond 2100.[177] (see Fig. 1 for a comparison of the $C0_2$ emissions of synthetic fuels versus conventional fossil fuels).

Mike Baly, President of the American Gas Association, comments: "Gas and coal are the country's two largest energy sources and we ought to be working to displace imported oil."[178] Unfortunately, it is not just foreign oil that will be displaced, but energy efficiency and renewable energy systems as well. It is ironic that the new power systems that are being implemented today to burn "clean burning" natural gas may well be burning gasified coal (or just about any low-grade carbon-based fuel) tomorrow when gas prices are high, and, in the meantime, cheap gas is excluding efficiency and renewables from the energy marketplace for decades to come. What are euphemistically called "clean-coal" processes, such as combined cycle coal gasification systems, emit nearly the same quantity of CO_2 as do conventional coal plants.[179]

Just as the major gas producers are also the traditional "Seven Sisters" of the oil industry, many coal companies are at least partially owned by the petroleum industry. What a different future might await the world if these industrial giants would combine their knowledge and experience to cooperate on, and profit from, research and development of clean, sustainable energy production rather than the continued commitment to fossil fuels.